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Chronic Obstructive Pulmonary Disease Pathophysiology

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Chronic Obstructive Pulmonary Disease

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Introduction:

Chronic Obstructive Pulmonary Disease

- Chronic obstructive pulmonary disease is a common condition that causes inflammation in the lungs (Ji et al., 2020)
- A preventable and treatable disease that is characterized by limited airflow due to inflammation that is not fully reversible (Elisha et al., 2022)
- Two specific disorders provide the model for pathological changes in COPD: emphysema, and bronchitis (Elisha et al., 2022)M
- Chronic bronchitis: hypersecretion of mucus with productive cough for three months in two consecutive years (McCance & Huether, 2014)
- Emphysema: permanent and abnormal enlargement of airways with alveolar wall destruction and fibrosis (McCance & Huether, 2014)

Why Chronic Obstructive Pulmonary Disease?

- COPD is the fourth leading cause of death in the United States (Centers for Disease Control and Prevention [CDC], 2021)
- Patients with COPD had a 13-day mortality rate of 13%, compared with only 5.3% without COPD after undergoing surgery (Flynn et al., 2020)
- Risk factors are common in everyday life: tobacco smoke, occupational smoke/chemicals, indoor air pollution from heating and cooking, and outdoor air pollution (McCance & Huether, 2014)
- COPD is an independent risk factor associated with complications and death following surgery (Lee et al., 2020)

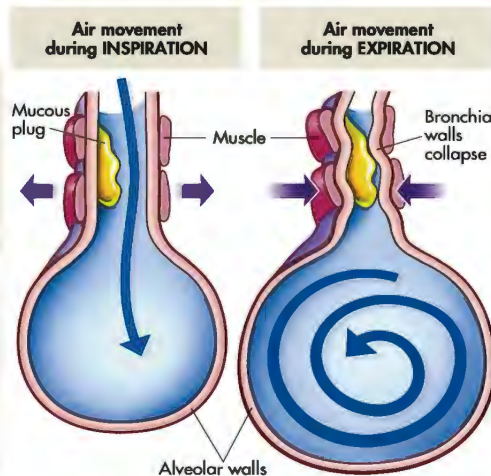
Pathophysiological Process

Signs & Symptoms

- Hallmark S/S of COPD: productive cough, dyspnea on exertion, wheezing/rhonchi breath sounds, pursed lip breathing (Elisha et al., 2022)
- Decrease in FEV1 spirometry test results (Elisha et al., 2022)
- Arterial blood gas analysis shows hypoxemia with respiratory acidosis; PaO₂ < 60 mmHg with PaCO₂ > 45 mmHg (Elisha et al., 2022)
- Chronic bronchitis: decreased exercise tolerance, wheezing, and shortness of breath with copious sputum production and cough, and frequent pulmonary infections (McCance & Huether, 2014)
- Emphysema: dyspnea on exertion progressing to dyspnea at rest, very little coughing and sputum production, tachypnea with prolonged expiration and accessory muscle use, barrel chest appearance, and tripod breathing position (McCance & Huether, 2014)

Underlying Pathophysiology

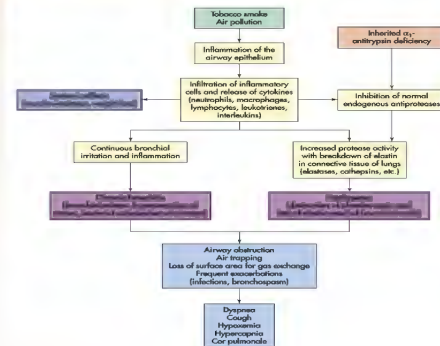
- The pathological changes occur in the large and small airways and the lung parenchyma (McCance & Huether, 2014)
- Irritant exposure mobilizes macrophages, neutrophils, and lymphocytes in the lungs leading to inflammation and cellular death (McCance & Huether, 2014)
- Chronic bronchitis: continual bronchial inflammation increases the size and number of mucus glands leading to copious, thick mucus that cannot be cleared due to impaired ciliary function (McCance & Huether, 2014)
- Eventual involvement of all airways leads to obstruction and V/Q mismatch (McCance & Huether, 2014)
- Emphysema: alveolar destruction through the breakdown of elastin and cellular apoptosis leading to the decreased area for gas exchange (McCance & Huether, 2014)
- Alveolar destruction creates large blebs and produces a V/Q mismatch and loss of elastic recoil (McCance & Huether, 2014)



McCance & Huether, 2014, pg. 1269)

Significance of Pathophysiology

- Systemic abnormalities, such as renal and hormonal abnormalities, malnutrition, muscle wasting, osteoporosis, and anemia, are associated with COPD (McCance & Huether, 2014)
- The impaired defense mechanism from lack of clearance and ciliary function lends patients susceptible to pulmonary infections (McCance & Huether, 2014)
- Increased work of breathing results from air being trapped in the lungs from loss of elastic recoil (McCance & Huether, 2014)
- Hyper-expansion of the chest results in hypoventilation and hypercapnia as the disease progresses (McCance & Huether, 2014)
- Severe hypercapnia can result in CNS depression and somnolence requiring mechanical ventilation (Elisha et al., 2022)
- Pulmonary hypertension from COPD can result in increased stress on the right side of the heart and lead to Cor Pulmonale or failure (McCance & Huether, 2014)
- Difficulty breathing restricts activities patients enjoy and dealing with a serious illness can contribute to the development of depression (Mayo Clinic, 2022).



McCance & Huether, 2014, pg. 1268)

Diagnosis and Treatment

- Pulmonary function tests:
 - Measure lung volumes, capacity, rates of flow, and gas exchange to show how well your lungs are working (John Hopkins Medicine, 2019)
- Chest radiography:
 - X-ray and CT scans (McCance & Huether, 2014)
- Blood gases (McCance & Huether, 2014)
- Differential Diagnosis: onset in midlife with slow progression; irreversible airflow limitation; dyspnea during exercise; smoking history (Elisha et al., 2022)
- Pharmacologic management (McCance & Huether, 2014):
 - Inhaled anticholinergic agents
 - Inhaled beta-agonist agents
 - Inhaled corticosteroid agents
- Drugs can only slow down the symptoms of the patient (Ji et al., 2020)
- Pulmonary rehabilitation, improved nutrition, and breathing techniques can improve symptoms (McCance & Huether, 2014)
- Oxygen therapy for chronic hypoxemia (McCance & Huether, 2014)
- Lung volume reduction surgery or transplantation may be considered (McCance & Huether, 2014)

Implications for Nursing Care

- Proper education on smoking cessation as disease progression can be halted if the patient discontinues smoking (McCance & Huether, 2014)
- Patients with COPD are at high risk for developing postoperative pulmonary complications (Park et al. 2020)
 - Similar education to quit smoking prior to surgery to improve postoperative pulmonary infection risks (Ji et al., 2020)
- Preoperative evaluation is pertinent to determining the severity of the disease and optimizing the patient for surgery by:
 - Inflammation reduction, secretion clearance, and infection treatment (Elisha et al., 2022)
- Continuous oxygen has shown improved survival for COPD patients; however, smoking is an absolute contraindication as oxygen is highly flammable (Lindford et al., 2006)
- Encouragement of pulmonary toilet maneuvers and incentive spirometry in the postoperative period to mobilize secretions and improve ventilation (Elisha et al., 2022)
- Low-tidal volume ventilation, conservative fluid administration, and sugammadex NMB reversal can improve postoperative pulmonary complications (Park et al. 2020)

Conclusions

- Chronic obstructive pulmonary disease is preventable through avoidance of smoking tobacco and chemical or environmental irritants (McCance & Huether, 2014)
- Smoking is the single most modifiable risk factor in developing COPD (Elisha et al., 2022)
- COPD symptoms are largely manageable; however, exacerbations occur where there is an increased severity of symptoms that can result in hospitalization (Mayo Clinic, 2022)
- Patients should seek a medical professional's help if treatment is not improving symptoms or there is evidence of infection (Mayo Clinic, 2022)
- Immediate medical care should be sought if patients experience rapid heartbeat, bluish fingernails, inability to catch their breath, or if they have a foggy memory and trouble concentrating (Mayo Clinic, 2022)

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